

**Claims**

1. A nitride semiconductor light emitting device comprising:

- 5       an n-type nitride semiconductor layer;  
      an In-containing super lattice structure layer formed above the n-type nitride semiconductor layer;  
      a first electrode contact layer formed above the super lattice structure layer;  
10       a first cluster layer formed above the first electrode contact layer;  
      a first In-containing nitride gallium layer formed above the first cluster layer;  
      a second cluster layer formed above the first In-containing nitride gallium layer;  
15       an active layer formed above the second cluster layer;  
      a p-type nitride semiconductor layer formed above the active layer; and  
      a second electrode contact layer formed above the p-type nitride semiconductor layer.
- 20

2. The device according to claim 1, wherein the active layer comprises:

- 25       a first quantum well layer having an  $\text{In}_y\text{Ga}_{1-y}\text{N}$  well layer/ $\text{In}_z\text{Ga}_{1-z}\text{N}$  barrier layer structure;  
      a second In-containing nitride gallium layer formed above the first quantum well layer; and  
      a second quantum well layer formed above the second In-containing nitride gallium layer to have an  $\text{In}_y\text{Ga}_{1-y}\text{N}$  well layer/ $\text{In}_z\text{Ga}_{1-z}\text{N}$  barrier layer structure.
- 30

3. The device according to claim 1, further comprising a buffer layer formed down the n-type nitride semiconductor layer, and a substrate formed down the buffer layer.

35

4. The device according to claim 1, wherein the n-type

nitride semiconductor layer is doped with indium (In).

5        5. The device according to claim 3, wherein the buffer layer has one selected from an AlInN structure, an AlInN/GaN layered structure, an InGaN/GaN super lattice structure, an In<sub>x</sub>Ga<sub>1-x</sub>N/GaN layered structure, and an Al<sub>x</sub>In<sub>y</sub>Ga<sub>1-x-y</sub>N/In<sub>z</sub>Ga<sub>1-z</sub>N/GaN layered structure.

10       6. The device according to claim 1, wherein the first electrode contact layer is a Si-In co-doped nitride gallium layer.

15       7. The device according to claim 1, wherein the first cluster layer and/or the second cluster layer are formed to have a thickness of atomic scale.

      8. The device according to claim 1, wherein the cluster layers are formed of SiN<sub>a</sub>.

20       9. The device according to claim 1, wherein the first In-containing nitride gallium layer has a surface shape grown in a spiral mode.

25       10. The device according to claim 1, wherein the first In-containing nitride gallium layer has a surface shape grown and connected up to a surface of the active layer.

30       11. The device according to claim 1, wherein the active layer has a single quantum well structure or a multi quantum well structure, which is has an In<sub>x</sub>Ga<sub>1-x</sub>N well layer/In<sub>y</sub>Ga<sub>1-y</sub>N barrier layer.

35       12. The device according to claim 11, wherein the In<sub>x</sub>Ga<sub>1-x</sub>N well layer/In<sub>y</sub>Ga<sub>1-y</sub>N barrier layer have indium contents of 0<x<0.35 and 0<y<0.1, respectively.

13. The device according to claim 1, wherein the first In-containing nitride gallium layer is expressed as  $\text{In}_x\text{Ga}_{1-x}\text{N}$ , and has a value of  $1 < x < 0.1$ .

5        14. The device according to claim 11, further comprising a  $\text{SiN}_x$  cluster layer formed between the  $\text{In}_x\text{Ga}_{1-x}\text{N}$  well layer and the  $\text{In}_y\text{Ga}_{1-y}\text{N}$  barrier layer of the active layer to have a thickness of atomic scale.

10       15. The device according to claim 1, further comprising a  $\text{SiN}_x$  cluster layer formed between the active layer and the p-nitride semiconductor layer to have a thickness of atomic scale.

15       16. The device according to claim 1, wherein the second electrode contact layer is formed to have one selected from an  $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$  super lattice structure, an  $\text{In}_x\text{Ga}_{1-x}\text{N}$  super grading structure and  $(\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$  super lattice)/n-GaN layered structure.

20       17. The device according to claim 1, wherein  $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$  layers of the second electrode contact layer have a thickness of 2-50 Å, respectively and alternately.

25       18. The device according to claim 14, wherein the  $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$  layers of the second electrode contact layer have a total thickness of less than 200 Å.

30       19. The device according to claim 1, wherein the second electrode contact layer has a doped silicon.

35       20. The device according to claim 1, wherein the n-type nitride semiconductor layer and the In-containing super lattice structure formed above the n-type nitride semiconductor layer is repeatedly formed.

21. The device according to claim 1, wherein the In-containing super lattice structure layer formed of  $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$  is provided at least one.

5        22. The device according to claim 1, wherein the p-type nitride semiconductor layer is formed to have a multi-layered structure in which a doped amount of magnesium is sequentially increased.

10       23. The device according to claim 2, wherein the second In-containing nitride gallium layer has a chemical formula of  $\text{In}_x\text{Ga}_{1-x}\text{N}$  ( $0 < x < 0.1$ ), and has a thickness of 300-2000 Å.

15       24. A nitride semiconductor light emitting device comprising:

        a first electrode contact layer;

        a first cluster layer formed above the first electrode contact layer;

20        a first In-containing nitride gallium layer formed above the first cluster layer;

        a second cluster layer formed above the first In-containing nitride gallium layer;

        an active layer formed above the second cluster layer; and

25        a p-type nitride semiconductor layer formed above the active layer.

30       25. The device according to claim 24, wherein the first and/or second cluster layers are/is formed of  $\text{SiN}_x$ .

35       26. The device according to claim 24, wherein the active layer comprises:

        a first quantum well layer having an  $\text{In}_y\text{Ga}_{1-y}\text{N}$  well layer/ $\text{In}_z\text{Ga}_{1-z}\text{N}$  barrier layer structure;

        a second In-containing nitride gallium layer formed above the first quantum well layer; and

a second quantum well layer formed above the second In-containing nitride gallium layer to have a structure of at least one of  $\text{In}_y\text{Ga}_{1-y}\text{N}$  well layer/ $\text{In}_z\text{Ga}_{1-z}\text{N}$  barrier layer.

5           27. The device according to claim 24, further comprising a second electrode contact layer formed above the p-type nitride semiconductor layer.

10           28. The device according to claim 27, wherein the second electrode contact layer has an In-containing super lattice structure.

15           29. The device according to claim 24, further comprising a Si-doped In-containing super lattice structure formed above the p-type nitride semiconductor layer.

30           30. The device according to claim 24, wherein the first electrode contact layer comprises:

an In-doped GaN layer;

20           an  $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$  super lattice structure layer formed above the In-doped GaN layer; and

a Si-In co-doped GaN layer formed above the  $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$  super lattice structure layer.

25           31. The device according to claim 24, wherein the active layer has a single quantum well structure or a multi quantum well structure, which has  $\text{In}_y\text{Ga}_{1-y}\text{N}$  well layer/ $\text{In}_z\text{Ga}_{1-z}\text{N}$  barrier layer.

30           32. The device according to claim 24, wherein the active layer is comprised of the  $\text{In}_y\text{Ga}_{1-y}\text{N}$  well layer and the  $\text{In}_z\text{Ga}_{1-z}\text{N}$  barrier layer, and a  $\text{SiN}_x$  cluster layer interposed therebetween.

35           33. The device according to claim 24, further comprising a  $\text{SiN}_x$  cluster layer formed between the active

layer and the p-nitride semiconductor layer.

34. A nitride semiconductor light emitting device comprising:

an n-type first electrode contact layer;

5 a first  $\text{SiN}_x$  cluster layer formed above the first electrode contact layer;

a first In-containing nitride gallium layer formed above the first  $\text{SiN}_x$  cluster layer;

10 a second  $\text{SiN}_x$  cluster layer formed above the first In-containing nitride gallium layer;

an active layer formed above the second  $\text{SiN}_x$  cluster layer, for emitting light;

a p-type nitride gallium layer formed above the active layer; and

15 an n-type second electrode contact layer formed above the p-type nitride gallium layer.

35. A nitride semiconductor light emitting device comprising:

20 an n-type first electrode contact layer;

a strain control layer formed over the first electrode contact layer;

25 an active layer formed over the strain control layer, for emitting light, to have an  $\text{In}_y\text{Ga}_{1-y}\text{N}$  well layer, a  $\text{SiN}_x$  cluster layer having a thickness of atomic scale, and an  $\text{In}_z\text{Ga}_{1-z}\text{N}$  barrier layer;

a p-type nitride gallium layer formed above the active layer; and

30 an n-type second electrode contact layer formed above the p-type nitride gallium layer.

36. A nitride semiconductor light emitting device comprising:

an n-type first electrode contact layer;

35 a strain control layer formed over the first electrode contact layer;

an active layer formed above the strain control layer;  
a  $\text{SiN}_x$  cluster layer formed above the active layer;  
a p-type nitride semiconductor layer formed above the  
 $\text{SiN}_x$  cluster layer; and  
5 an n-type second electrode contact layer formed above  
the p-type nitride semiconductor layer.

37. A nitride semiconductor light emitting device  
comprising:

10 an n-type first electrode contact layer;  
a strain control layer formed above the first electrode  
contact layer;  
an active layer formed above the strain control layer  
to have a first quantum well layer, a second quantum well  
15 layer, and an  $\text{In}_x\text{Ga}_{1-x}\text{N}$  layer interposed between the first  
quantum well layer and the second quantum well layer;  
a p-type nitride semiconductor layer formed above the  
active layer; and  
an n-type second electrode contact layer formed above  
20 the p-type nitride semiconductor layer.

38. A nitride semiconductor light emitting device  
comprising:

an n-type first electrode contact layer;  
25 an active layer formed above the first electrode  
contact layer, for emitting light;  
a p-type nitride semiconductor layer formed above the  
active layer; and  
an n-type second electrode contact layer formed above  
30 the p-type nitride semiconductor layer to have an  $\text{In}_x\text{Ga}_{1-x}\text{N}/\text{In}_y\text{Ga}_{1-y}\text{N}$  super lattice structure.